Claims

[c1] 1. A method of installing a fuel injector in an engine having an electronic control unit (ECU) for providing an electrical signal to activate the fuel injector to deliver fuel from the fuel injector, said method comprising the steps of:

providing a fuel injector for installation in a engine;

measuring a time delay in the fuel injector by determining an elapsed time between a time an electrical signal is sent to the fuel injector and a time fuel is initially delivered from the fuel injector; and

storing the time delay measured.

[c2] 2. The method of claim 1 wherein the step of storing the time delay comprises storing the time delay in a computer readable storage medium, and further comprising the steps of:

inputting the time delay to the ECU; and

using the time delay input to the ECU to determine timing of signals from the ECU to activate the fuel injector.

[c3] 3. The method of claim 2 wherein the step of inputting the time delay to the ECU comprises providing a service computer connectable to transmit the time delay from

the computer readable storage medium to the ECU.

[c4] 4. The method of claim 1 wherein the step of storing the time delay includes storing an identification characteristic of the fuel injector.

[c5] 5. The method of claim 4 wherein the step of storing the time delay includes storing a serial number of the fuel injector.

[c6] 6. A system to input fuel injector data in an ECU when replacing a fuel injector in an engine comprising:
a computer readable storage medium operable with a service computer connectable to transmit data to an ECU of an engine, the computer readable storage medium having thereon replacement fuel injector time delay data and a computer program which, when executed by the service computer, causes the service computer to write the replacement fuel injector time delay data to the ECU for use with a specified replacement fuel injector.

[c7] 7. The system of claim 6 wherein the computer program further causes the service computer to:
download an identification characteristic from the ECU;
determine which fuel injector is to be replaced;
read existing time delay data from the ECU for the fuel injector to be replaced; and

save the existing fuel injector time delay data for use by the computer program in an event that the specified replacement fuel injector is reinstalled in the engine.

[c8]   8.The system of claim 7 wherein the computer program further causes the service computer to acquire a fuel injector identification for each cylinder in the engine.

[c9]   9.The system of claim 7 wherein the computer program further causes the service computer to allow restoration of the existing injector time delay data and restricts such restoration to the engine in which the ECU has the replacement fuel injector time delay data written.

[c10]   10.The system of claim 7 wherein the computer program further causes the service computer to maintain a log of how the computer program is used to thereby restrict use of the existing time delay data and the replacement fuel injector time delay data.

[c11]   11.The system of claim 7 wherein the computer program further causes the service computer to read the written replacement fuel injector time delay data from the ECU and to verify accuracy of the written replacement fuel injector time delay data with the replacement fuel injector data on the computer readable storage medium.

[c12]   12.The system of claim 6 further comprising a produc-

tion fuel injector having an inherent time delay and wherein the production fuel injector is individually tested to determine an actual time delay representative of the inherent time delay.

[c13] 13. The system of claim 12 further comprising an ECU that has a standard service time delay data therein, and is preprogrammed to use the standard service time delay when a service fuel injector is installed and wherein the service fuel injector is manufactured with such toler- ances so as to use the standard service time delay.

[c14] 14. The system of claim 13 wherein the production fuel injector is manufactured with wider tolerances than the service fuel injector, but wherein operation of the pro- duction fuel injector using the actual time delay provides more precise timing of the fuel delivery than the service fuel injector using the standard service time delay.

[c15] 15. A method of servicing an engine requiring fuel injec- tor replacement comprising the steps of:
identifying a fuel injector in need of replacement by cylinder number;
establishing communication between a service computer and an ECU of the engine;
downloading ECU, engine, and fuel injector data from the ECU to the service computer;

writing replacement fuel injector time delay data in the
ECU for a replacement fuel injector for the cylinder num-
ber identified; and
installing the replacement fuel injector in the cylinder
number identified.

[c16]   16. The method of claim 15 wherein the step of down-
loading further includes downloading existing fuel injec-
tor time delay data and the method further includes the
steps of storing the existing fuel injector time delay
data, and restricting a user to restoring the existing fuel
injector time delay data in the engine from which it was
downloaded.

[c17]   17. The method of claim 16 further comprising the steps
of:
displaying an injector serial number and injector type for
each cylinder;
determining if the replacement fuel injector time delay
data has been uploaded previously; and if so,
determining whether any injector serial number in the
engine matches a serial number of the replacement fuel
injector; and if so,
allowing restoration of the existing fuel injector time de-
lay data.

[c18]   18. The method of claim 15 further comprising the steps

of:

reading the written replacement fuel injector time delay data back from the ECU;

displaying the cylinder number in which the replacement fuel injector is to be installed; and

verifying the written replacement fuel injector time delay data with the replacement fuel injector time delay data.

[c19]   19. The method of claim 15 further comprising the steps of:

supplying a production fuel injector having a time delay wherein the production fuel injector is tested to determine a particular time delay; and

supplying a computer readable storage medium with the production fuel injector wherein the computer readable storage medium has stored thereon time delay data that correspond to that particular production fuel injector and a computer program that is capable of causing the service computer to execute the steps of downloading, writing and installing.

[c20]   20. A fuel injector service pack comprising:

(A) a single replacement fuel injector having a specific time delay that is experimentally determined for that particular fuel injector; and

(B) a computer readable storage medium having stored thereon:

(i)a data file containing a serial number and the specific time delay for the single replacement fuel injector; and
(ii)a computer program comprising instructions which, when executed by a computer, cause the computer to:
(1)allow identification of a cylinder in a fuel injected engine for which a fuel injector is to be replaced;
(2) read and store existing fuel injector time delay data from an ECU of the fuel injected engine; and
(3)write the particular time delay from the data file to the ECU for use with the single replacement fuel injector.
21.The fuel injector service pack of claim 20 wherein the computer readable storage medium further comprises a log file that is used by the computer program to track how the data file is used and ensure that the specific time delay is not used with another fuel injector.

[c21] 22.The fuel injector service pack of claim 20 wherein the computer program further causes the computer to:
allow restoration of the existing fuel time delay data if the single replacement fuel injector did not solve a user problem and restricts use of the existing fuel injector time delay data and the original fuel injector by:
writing a serial number of the single replacement fuel injector to the ECU when the custom time delay data are written to the ECU;
if the last use of the computer program was to replace

data, read and compare each fuel injector serial number in the ECU with the serial number of the single replacement fuel injector as stored in the data file; and if a match is present:

allow the existing fuel injector time delay data to be written back into the ECU; and

direct that the original fuel injector be installed in the cylinder identified.

[c22] 23. A method of providing fuel injectors for an engine comprising the steps of:

supplying a production fuel injector with relaxed tolerances as compared to a standard fuel injector;

acquiring a specific time delay that characterizes the production fuel injector;

writing the time delay to a transportable computer readable medium; and

providing a computer program on a computer readable medium that, when executed, causes a computer to load the time delay into an ECU of an engine in which the production fuel injector is to be installed.

[c23] 24. The method of claim 23 further comprising the step of testing each particular production fuel injector to acquire a distinct time delay for that particular production fuel injector.

[c24] 25.The method of claim 23 further comprising the steps of:

reading and storing existing fuel injector time delay data from the ECU; and

allowing restoration of an existing fuel injector time delay and restricting use of the existing fuel injector time delay and the fuel injector by:

writing a serial number of the production fuel injector to the ECU;

upon a request to restore data, reading and comparing each fuel injector serial number in the ECU with the serial number of the production fuel injector; and if a match is present:

allowing the existing fuel injector time delay to be written back into the ECU; and

directing that the original fuel injector be installed in the cylinder identified.

[c25] 26.The method of claim 23 further comprising the step of characterizing the fuel injector with a third order polynomial.

[c26] 27.A system to install fuel injector data in an ECU when installing a fuel injector in an engine comprising:
a computer readable storage medium operable with a service computer connectable to transmit data to an ECU of an engine, the computer readable storage medium

having thereon fuel injector time delay data specific to a particular fuel injector and a computer program which, when executed by the service computer, causes the service computer to write the fuel injector time delay data to the ECU for the particular fuel injector.

[c27] 28. The system of claim 27 further comprising a replacement fuel injector suitable for use on a 2–cycle engine.

[c28] 29. The system of claim 28 wherein the 2–cycle engine is an outboard marine engine.

[c29] 30. A system to input fuel injector data in an ECU of an engine when installing a fuel injector in the engine comprising:

an engine having an ECU that controls a plurality of fuel injectors, wherein each fuel injector is of a type that directly injects gasoline into a cylinder of the engine; and

a computer readable storage medium operable with a computer connectable to transmit data to the ECU of the engine, the computer readable storage medium having thereon fuel injector time delay data and a computer program which, when executed by the computer, causes the computer to write the fuel injector time delay data to the ECU for use only with a specified fuel injector in a specified cylinder of the engine.

[c30]   31. The system of claim 30 wherein the computer pro-
gram further causes the computer to:
download an identification characteristic from the ECU;
determine a fuel injector to replace;
read existing fuel injector time delay data from the ECU
for the specified fuel injector to be replaced; and
save the existing fuel injector time delay data if the fuel
injector is to be reinstalled.

[c31]   32. The system of claim 30 wherein the fuel injector is
configured to deliver gasoline that is entrained in a gas.

[c32]   33. The system of claim 30 wherein the fuel injector is
configured to deliver gasoline that is not entrained in a
gas.

[c33]   34. The system of claim 33 wherein the fuel injector is
configured to deliver gasoline by a pressure surge.

[c34]   35. The system of claim 34 wherein the fuel injector is
configured to deliver gasoline by a pressure differential.

[c35]   36. A system to input fuel injector data in an ECU when
installing a fuel injector in an engine comprising:
means for identifying a fuel injector by cylinder number
of an engine;
means for establishing communication between a com-
puter and an ECU of the engine;

means for downloading an identification characteristic from the ECU; and

means for writing fuel injector time delay data in the ECU for a specific fuel injector for the cylinder number identified.

[c36] 37. A system to input fuel injector data in an ECU when installing a fuel injector in an engine comprising:
a computer readable storage medium operable with a service computer connectable to transmit data to an ECU of an engine, the computer readable storage medium having thereon fuel injector time delay data and a computer program which, when executed by the service computer, causes the service computer to write the fuel injector time delay data to the ECU for use with a specified fuel injector.

[c37] 38. A system to replace fuel injector data in an ECU when replacing a fuel injector in an engine comprising:
a replacement fuel injector and corresponding replacement fuel injector time delay date specific for that replacement fuel injector; and
a computer readable storage medium operable with a service computer connectable to transmit data to an ECU of an engine, the computer readable storage medium having thereon the replacement fuel injector time delay data and a computer program which, when executed by

the service computer, causes the service computer to write the replacement fuel injector time delay data to the ECU for the specific replacement fuel injector.

[c38]   39. The system of claim 38 further comprising a replacement fuel injector suitable for use on a 2-cycle engine.

[c39]   40. The system of claim 39 wherein the 2-cycle engine is an outboard marine engine.

[c40]   41. A system to input fuel injector data in an ECU of an engine comprising:
an engine having an ECU that controls a plurality of fuel injectors, wherein each fuel injector is of a type that directly injects gasoline into a cylinder of an internal combustion engine; and
a computer readable storage medium operable with a computer connectable to transmit data to the ECU of the engine, the computer readable storage medium having thereon replacement fuel injector time delay data specific for each fuel injector and a computer program which, when executed by the computer, causes the computer to write the fuel injector time delay data to the ECU for use only with a specified replacement fuel injector in a specified cylinder of the engine.

[c41]   42.The system of claim 41 wherein the computer pro-

gram further causes the service computer to:

download an identification characteristic from the ECU;

determine which fuel injector is to be replaced;

read existing fuel injector time delay data from the ECU for the specified replacement fuel injector to be re-placed; and

save the existing fuel injector coefficient data for reuse in the ECU if the replacement fuel injector does not solve a service problem.

[c42]   43. The system of claim 41 wherein the fuel injector is configured to deliver gasoline that is entrained in a gas.

[c43]   44. The system of claim 41 wherein the fuel injector is configured to deliver gasoline that is not entrained in a gas.

[c44]